PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

Improvements in or relating to Liquid Level Indicating Arrangements of the Transparent Gauge Type.

We, ELECTRICAL IMPROVEMENTS LIMITED, a Company registered under the Laws of Great Britain, of Carliol House, Newcastle-upon-Tyne, in the County of Northumberland, and CHARLES LORD BLACKBURN, British Subject, of 2, Ryder Street, Westminster, London, S.W. 1, do hereby declare the nature of this invention to be as follows:—

This invention relates to liquid level indicating arrangements of the transparent gauge type, wherein an indication of the liquid level is obtained at a distant observing point owing to the difference between the refractive indices of the liquid and of the gas or vapour above it. Although not limited thereto, the invention is more especially applicable to the indication of the water level in high pressure boilers or steam generators having high combustion chambers, wherein it is desired to render the indication readily visible on the firing floor which is often thirty or more feet below the level at which the gauge must be installed. In such arrangements difficulty is experienced in obtaining a satisfactory indication owing to the fact that when the gauge includes glass or like prisms in contact with the water and steam column the surfaces of such prisms rapidly become etched or defaced to such an extent as to interfere with the indications obtained.

The present applicants' copending British Patent Application No. 35,097 of 1931, (Serial No. 392,642), from which the present application has been divided, has for its object to provide a simple practical construction of gauge which will enable such difficulties to be avoided.

In the arrangement according to this copending patent application the gauge comprises two sheets of mica or other corrosion-resisting material inclined at a small angle to one another and separated by a wedge-shaped central space containing the column of liquid whose level is to be indicated and the gas or vapour above it, and a substantially flat beam of light is directed on to one of the sheets at such an angle that after refraction through the central space it will emerge in the form of two slightly divergent substantially flat beams respectively above and below the liquid level, so that one only of such emergent beams will be visible at a chosen observing point. Thus, if a single incident beam of light is employed, the gauge will appear at the observing point with its upper (or lower) part brightly illuminated and its lower (or upper) part dark, the liquid level being indicated by the sharply defined edge of the bright part.

In order to avoid misinterpretation of the indication in such an arrangement, more especially at times when the liquid level has fallen to the bottom of the gauge, the arrangement according to the present invention employs two differently coloured flat beams of light which are incident on the gauge at such an angle to one another that the upper emergent beam of one colour and the lower emergent beam of the other colour will both be directed to the observing point. The two differently coloured beams can be produced from a single source of light, for example by providing two narrow slots with differently coloured windows between the source and the gauge, or by optically projecting a coloured image of the source by the side of the source itself, or in other ways.

Although the gauge may be viewed directly from the observing point, it will usually be desirable to provide some form of optical projecting arrangement, on which only the chosen emergent differently coloured beams are incident and which will project an image of the gauge to a convenient position. For this purpose it is preferred to employ the projecting arrangement forming the subject of the present applicants' copending British Patent Application No. 26,588 of 1931 (Serial No. 387,752), wherein an optical projecting system including one or more lenses is employed to focus a real image of the gauge on to a diffusing screen and an optical condensing system is provided

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to concentrate the light from the source on to the lens or lenses of the projecting system.

The invention may be carried into practice in various ways, but the following may be instanced as some convenient practical arrangements according thereto. These arrangements will, for convenience, be described with reference to the indication of the water level in a high pressure steam boiler having a high combustion chamber, wherein the indications of the gauge are reproduced at a convenient position on the firing floor by means of a projecting arrangement according to the copending British Patent Application No. 26,588 of 1931 (Serial No. 387,752) above mentioned.

The first arrangement, as applied to such an installation, comprises broadly a water level gauge, a source of light for illuminating the gauge, a diffusing screen at eye level on the firing floor, a projecting lens for focussing a real image of the gauge on the screen, suitably mounted plane mirrors for deflecting the horizontal emergent beam from the gauge vertically downwards through the projecting lens and again horizontally on to the diffusing screen, and a condensing optical system for concentrating the light from the source on to the projecting lens, with or without tubes for enclosing the rays of light to exclude stray light and dust.

The gauge itself comprises two prisms mounted vertically in a box-like structure having suitable openings in its front and back walls adjacent to the prisms for the passage of the light. The prisms are held in position in the box by means of internal shoulders therein, against which the prisms are forced by means of clamping screws at the front and back of the box, suitable packing material being provided to render the central space between the prisms fluid-tight. This central space is connected by conduits at the upper and lower ends of the box respectively to the steam space and the water space of the boiler. Sheets of mica or other corrosion-resisting material are provided between the inner surfaces of the prisms and the central space containing the water and steam column, these sheets being in close contact with the glass or other material of which the prisms are made. The inner surfaces of the prisms, and consequently also the mica sheets, are inclined to one another at a small angle, say, 10°, so that the water and steam column is itself prismatic in shape. This may be effected by making one of the prisms in the form of a parallel-sided flat plate, and the other with its outer surface parallel to the surfaces of the first prism and its inner surface inclined thereto at the chosen small angle. Alternatively the two prisms may be of similar shape with their outer surfaces parallel to one another and their inner surfaces inclined at an angle of 5° to the outer surfaces, so that the two inner surfaces lie at an angle of 10° to each other.

Thus a beam of light substantially confined to a vertical plane and incident approximately perpendicularly on the outer surface of the first prism will be refracted at slightly different angles through the water and through the steam, and again through the second prism so that two flat beams of light respectively above and below the water level will emerge from the gauge and will diverge from one another at a small angle.

For illuminating the gauge an electric lamp is employed which gives a small but intense source of light, the lamp being adjustable in position for focussing purposes. Since considerably less illumination will usually be required at night than in the day time, it is preferable to provide means for varying the voltage applied to the lamp for adjustment purposes in order to increase the life of the lamp. It is also desirable to provide a spare lamp in readiness for use in the event of failure of the main lamp, the two lamps being mounted on a movable frame, so that the spare lamp can be brought into service without waste of time.

The two differently coloured flat beams of light are preferably derived from the same source of light. This may be effected in various ways but in one convenient arrangement the point source of white light is disposed slightly to one side of the centre of curvature of a concave spherical mirror and a coloured screen is interposed between the source and the mirror. Thus some of the rays from the light pass through the screen and after reflection in the mirror pass again through the screen to a point focus on the other side of the centre of curvature. There will thus in effect be two point sources of light close together, one white and one coloured for illuminating the gauge.

The optical condensing system may consist of a curved mirror behind the lamp or of a condensing lens or lens system between the lamp and the gauge or of a combination of mirror and lens, the arrangement in each case being such that two intense flat beams of light consisting of approximately horizontal rays concentrated in two slightly convergent vertical planes are directed on to the gauge, each flat beam emerging from the gauge in the form of two divergent flat beams respectively above and below the water level.

The arrangement is such that the coloured beam above the water level emerges from the gauge in the same vertical plane as the white beam below the water level, these beams being concentrated on the projecting lens, so that as much as possible of the light from the source is utilised.

The projecting lens is positioned approximately midway between the gauge and the diffusing screen and has a large focal length such that the real image of the gauge focussed on the diffusing screen is of the same order of size as the gauge itself. Since a single projecting lens will invert the image, it is desirable to provide two plane mirrors instead of one at one of the two reflecting points in order that an erect image may be obtained on the diffusing screen (assuming that the two horizontal portions of the beam of light are both in the same direction and sense). This will be unnecessary in cases where the upper mirror can conveniently be located behind the gauge and the lower mirror behind the diffusing screen. The provision of two mirrors at, say, the upper reflecting point is however of advantage for initial setting purposes, since by mounting the mirrors adjustably, focussing and levelling adjustments can readily be made when the apparatus is initially installed, the directly accessible portions of the apparatus being rigidly fixed in position. The mirrors are preferably silvered on their front surfaces or are alternatively made of very thin glass with the usual back-surface silvering in order to avoid troubles from double reflection. It is also desirable so to mount the mirrors that they can be readily withdrawn for cleaning purposes. The lower mirror should be set back from the diffusing screen far enough to prevent any light entering through the diffusing screen from being reflected back again through the screen. The tubes enclosing the paths of the light (if provided) are made of metal and the joints are made substantially dust-tight in order to avoid loss of light from diffusion or obstruction by particles of dust. The dust can be more effectively excluded by filling the interior of the tubes with clean compressed air, so that flow will take place in an outward direction through any slight leakage, and will thus prevent the entry of dust particles. The diffusing screen is made of ground glass chosen to diffuse the light from the image over the desired angle. A hood should also be provided on the screen to shade it from direct external light. The interior surface of the enclosing tubes should be blackened or otherwise treated in order to prevent the upper beam from the gauge from being reflected on to the projecting lens.

The above arrangement enables a well-defined and brightly illuminated image of the gauge to be reproduced at eye level on the firing floor in such a manner that it can be readily seen over a wide angle of vision. The indication obtained on the diffusing screen consists of a coloured upper part and a white lower part, the water level being indicated by the dividing line between the two parts of the image. This arrangement has the important advantage that there is no risk of failure of the source of light being misinterpreted as a fall in the water level to the bottom of the gauge as might happen with the use of a single colour.

Although described with reference to a boiler installation provided with a water level gauge at a height above the firing floor, the arrangement can be applied with suitable modifications to other purposes. Thus for instance the arrangement may also be employed with advantage in some cases, for example, with pulverised fuel boilers, where the firing floor is commonly at more or less the same height as the gauge, but where the gauge is located at the back of the boiler. The arrangement is generally applicable to liquid level indicating purposes, where it is desired to obtain an indication at a distance from the point at which the gauge is installed.

Again the forms of gauge described may be employed with other arrangements for projecting the indication to a distant point, or they may be directly viewed without a projecting arrangement. In the latter case the above described arrangement can be simplified by providing two slots with differently coloured windows between the source of light and the gauge, with or without a cylindrical lens interposed between the slots and the gauge, in place of the optical condensing arrangements described. The use of differently coloured beams is of especial advantage in the case of direct vision in that the observer can readily distinguish between the various emergent beams.

The construction of liquid level gauge more particularly described may also be modified in various ways within the scope of the invention. Thus for instance, instead of mounting the mica sheets in close contact with the inner surfaces of glass prisms, one or each of the sheets may be separated from the glass prisms by distance pieces so as to form a wedge-shaped space, which may be filled preferably with a liquid. In such a case however it is necessary to equalise the pressures on the two sides of the mica sheet. This may be effected by providing a small hole through the mica sheet at its upper

end, so that the space behind the sheet becomes filled with the water of condensation. Alternatively an entirely separate body of liquid may be used and in this case the liquid may be supplied from a closed chamber having in its wall a flexible diaphragm exposed to the pressure in the boiler steam space. Such modifications of the gauge enable the glass prisms to be in the form of parallel-sided flat plates.

Dated this 2nd day of March, 1933.

KILBURN & STRODE,
Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements in or relating to Liquid Level Indicating Arrangements of the Transparent Gauge Type.

We, ELECTRICAL IMPROVEMENTS LIMITED, a Company registered under the Laws of Great Britain, of Carliol House, Newcastle-upon-Tyne, in the County of Northumberland, and CHARLES LORD BLACKBURN, British Subject, of 2, Ryder Street, Westminster, London, S.W. 1, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to liquid level indicating arrangements of the transparent gauge type, wherein an indication of the liquid level is obtained at a distant observing point owing to the difference between the refractive indices of the liquid and of the gas or vapour above it. Although not limited thereto, the invention is more especially applicable to the indication of the water level in high pressure boilers or steam generators having high combustion chambers, wherein it is desired to render the indication readily visible on the firing floor which is often thirty or more feet below the level at which the gauge must be installed. In such arrangements difficulty is experienced in obtaining a satisfactory indication owing to the fact that when the gauge includes glass or like prisms in contact with the water and steam column the surfaces of such prisms rapidly become etched or defaced to such an extent as to interfere with the indications obtained. The present applicants' co-pending British Patent Application No. 35,097 of 1931 (Serial No. 392,642), from which the present application has been divided, relates to a liquid level indicating arrangement employing a simple practical form of gauge in which such difficulty is avoided.

When a gauge of the kind described in the specification accompanying this co-pending patent application is illuminated with ordinary white light, the indication is liable to misinterpretation more especially at times when the liquid level has fallen to the bottom of the gauge or alternatively has risen to the top of the gauge, and a further difficulty also arises in cases where the gauge itself is directly viewed in that it becomes almost impossible to distinguish the brightly illuminated parts of the gauge from the relatively dark parts except at comparatively short distances from the gauge.

The liquid level arrangement according to the present invention employs a transparent liquid level gauge so arranged that two parallel rays of light incident on the gauge respectively above and below the liquid level will be deflected by the gauge through different angles, and two differently coloured beams of light are directed on to the gauge at such an angle to one another that from a chosen observing point the gauge will appear as of one colour above the liquid level and of the other colour below the liquid level.

With this arrangement it is often convenient to provide some form of optical projecting system, on which only the beams passing to the chosen observing point are incident and which will project an image of the gauge to a convenient position. For this purpose it is preferred to employ the projecting arrangement described in the present applicants' British Patent Specification No. 387,752, wherein an optical projecting system including one or more elements is employed to focus a real image of the gauge on to a diffusing screen and an optical condensing system is provided to concentrate the light from the source on to the element or elements of the projecting system.

The two differently coloured beams can be produced from a single source of light, for example by providing two narrow slots with differently coloured windows between the source and the gauge, or by optically

projecting a coloured image of the source by the side of the source itself, or in other ways.

The use of two different colours according to the invention is of especial value in cases where the gauge is to be directly viewed, since by suitable choice of coloured beams of generally similar intensity it becomes possible to distinguish satisfactorily between the differently coloured upper and lower parts of the gauge at very considerable distances. In such cases it is convenient to employ two colour screens evenly illuminated from a suitable source or alternatively two differently coloured glow discharge tubes and to mount such screens or tubes side by side in the focal plane of a lens or mirror, from which the differently coloured beams are directed on to the gauge.

The invention may be carried into practice in various ways, but some convenient arrangements according thereto are illustrated by way of example in the accompanying drawings, in which—

Figures 1 and 2 are respectively horizontal and vertical sections through one construction of liquid level gauge, Figure 2 being a section on the line 2—2 of Figure 1, and being drawn on a smaller scale,

Figures 3—5 respectively show horizontal sections of alternative constructions of gauge,

Figures 6 and 7 are diagrammatic views of two alternative forms of an optical projecting arrangement for projecting an image of the gauge to a distance,

Figures 8 and 9 are two diagrammatic plan views illustrating the paths of the rays respectively below and above the liquid level in the projecting arrangement of Figure 6, and

Figures 10—12 are diagrammatic plan views respectively of three modified arrangements for use when the gauge is directly viewed.

These arrangements will, for convenience, be described with reference to the indication of the water level in a high pressure steam boiler having a high combustion chamber, wherein it is desired to observe the indications of the gauge from the firing floor which may be thirty feet or more below the gauge. The constructions of gauge illustrated in Figures 1—5 are generally of the kind described in British Patent Specification No. 263,638, but modified to suit the requirements of the present invention.

In the construction of gauge shown in Figures 1 and 2, two prisms A^1, A^2 of glass or other suitable material are mounted vertically in a box-like structure B having openings B^1, B^2 in its front and back walls adjacent to the prisms for the passage of the light. The prisms are clamped against internal shoulders B^3 in the box by means of insets C^1, C^2 which are forced against the prisms by bolts C^3. The central space D between the inner surfaces of the prisms A^1, A^2 is connected by valve-controlled conduits D^1, D^2 at the upper and lower ends of the box respectively to the steam space and the water space of the boiler, and suitable packing material D^3 is provided around the edges of the inner surfaces of the prisms to render the central space fluid-tight. Sheets E^1, E^2 of mica or other corrosion-resisting material are provided between the inner surfaces of the prisms A^1, A^2 and the central space D containing the steam and water column, these sheets being in close contact over the whole surface with the glass or other material of which the prisms are made.

The inner surfaces of the prisms A^1, A^2, and consequently also the mica sheets E^1, E^2, are inclined to one another at a small angle, so that the water and steam column in the central space D is itself prismatic in shape. The actual angle of the wedge formed by the central space D may vary, but where very high pressures have to be withstood, it is desirable to keep the wedge angle small in order to avoid setting up heavy shear stresses in the mica sheets. When a projecting arrangement is used, it will usually be satisfactory to employ a wedge-angle of, say, 10°, but when the gauge is to be directly viewed a larger angle of, say, 20° is preferable. In the arrangement shown in Figures 1 and 2 the wedge angle is 20°, the two prisms A^1, A^2 being similar in shape with their outer surfaces parallel to one another and their inner surfaces inclined at any angle of 10° to the outer surfaces. A 10° wedge angle may be obtained by using two prisms each having a 5° angle.

Instead of employing two similar prisms A^1, A^2 as in Figures 1 and 2, a similar effect may be obtained, as shown in Figure 3, by making one of the prisms in the form of a parallel-sided flat plate A^4, the other prism A^3 having its outer surface parallel to the surfaces of the plate A^4 and its inner surface inclined thereto at the desired wedge angle. In the example shown in Figure 3, the wedge angle is 10°. In other respects, the construction of Figure 3 is similar to that of Figures 1 and 2.

In a further modification shown in Figure 4, two parallel-sided flat plates A^5, A^6 are employed, the box B being so shaped that these plates are inclined to one another at the desired wedge angle

(20° as shown). This modification necessitates the use of separate clamping screws C^5, C^6 in the front and back walls of the box, but the arrangement is otherwise similar to that of Figures 1 and 2.

In the foregoing constructions the mica sheets E^1, E^2 have in each case been arranged to withstand the pressure by being mounted in close contact with the inner surfaces of the prisms, but it is in some instances preferable to separate one or each of the mica sheets from the adjacent prism. Figure 5 illustrates one such arrangement in which the two mica sheets E^3, E^4 are separated from parallel-sided plates A^7, A^8 mounted parallel to one another by means of wedge-shaped distance pieces F, so that the two mica sheets are inclined to one another at the desired wedge angle (20° as shown). The small pockets F^1, F^2 between the mica sheets and the glass plates are preferably filled with liquid, but in order to keep the mica sheets flat, it is necessary to equalise the pressures on the two sides of each sheet. This may be satisfactorily effected in some instances by providing a small hole through the mica sheet at its upper end, so that the space behind the sheet becomes filled with the water of condensation. Alternatively, an entirely separate body of liquid may be used for filling the pockets F^1, F^2, and in this case the liquid may be supplied from a closed chamber having in its wall a flexible diaphragm exposed to the pressure in the boiler steam space. The construction is in other respects similar to that of Figures 1 and 2.

Other forms of gauge having plane operative surfaces may also be employed. It is usually preferable to employ a gauge of the plane surface type in order to facilitate the use of protective sheets of mica or other corrosion-resisting material, but it will be appreciated that the invention is not confined to the use of such gauges and that the gauge may be constructed in other ways, the essential characteristic being that the central space containing the steam and water column shall be in the form of or optically equivalent to a wedge, so that a beam of light incident on the gauge and substantially confined to a vertical plane will be refracted at different angles through the water and through the steam, so that two flat beams of light respectively above and below the water level will emerge from the gauge and will diverge from one another.

In cases where the indications of the gauge are to be reproduced at a convenient position on the firing floor, it is preferred to use the optical projecting arrangement described in British Patent Specification No. 387,752 above mentioned. Figures 6—9 illustrate diagrammatically a preferred form of such a projecting arrangement as employed with the present invention.

This arrangement comprises broadly in addition to the gauge G itself (assumed to be of the form shown in Figures 1 and 2 but with a wedge angle of 10°), an illuminating unit H including the source of light H^1, a paraboloidal condensing mirror H^2, a spherical reflector H^3, two colour screens H^4, H^5 and a small prism H^6, a projection unit J mounted on the firing floor and including a convex projecting lens J^1, a convex mirror J^2, an inclined plane mirror J^3 and a diffusing screen J^4, and a plane mirror L (Figure 6) or a pair of plane mirrors L^1, L^2 (Figure 7) for deflecting the chosen emergent beams from the gauge G vertically down to the projection unit J.

As the source of light H^1 in the illuminating unit H an electric lamp is employed which gives a small but intense source of light, the lamp preferably being a low-voltage lamp fed through a transformer from a.c. lighting mains. Means may be provided for reducing the voltage applied to the lamp at night-time when less illumination will usually be required, and a spare lamp may be provided which is mounted with the main lamp on a swinging frame to ensure rapid change-over if the main lamp fails. The condensing mirror H^2 preferably consists of a narrow vertical strip cut from a paraboloid of revolution having a horizontal axis, the strip lying to one side of the axis. The mirror strip is mounted vertically at a distance from the optical axis of the condensing system corresponding to its distance from the axis of the mirror blank from which it was cut, the lamp H^1 being disposed on the axis of the mirror H^2 and slightly displaced from the focus thereof, so that the light falling on the strip is reflected in the form of an approximately parallel (or rather slightly convergent) beam which passes to one side of the lamp and illuminates the whole length of the gauge G through the colour screens H^4, H^5 brightly and evenly without interference from the shadow of the lamp. The reflector H^3 similarly consists of a narrow vertical strip cut from a concave spherical mirror and is located with the lamp filament approximately at its centre of curvature. The main function of the condensing mirror H^2 is to focus a sharp image of the lamp filament on to the projecting lens J^1, and the arrangement is such that an intense flat beam of light K consisting of approximately horizontal rays more or

less concentrated in a vertical plane is directed on to the two colour screens H^4, H^5, which consist of narrow vertical transparent strips of different colours, for example red and green. The green rays K^1 shown in chain line in Figures 8 and 9 proceed straight on to the gauge G, but the red rays K^2 are deflected by the small prism H^6 so that they are incident on the gauge G at an angle to the green rays K^1 chosen to suit the wedge angle of the gauge. The green rays K^1 emerge from the gauge in the form of two divergent flat beams K^3, K^4, one of which (preferably the lower beam K^3 shown in Figure 8) is caused to pass to the projecting lens J^1. The red rays K^2 similarly emerge from the gauge in the form of two divergent flat beams K^5, K^6, of which the upper beam K^6 shown in Figure 9 lies vertically above the lower green beam K^3 and is directed on to the projecting lens J^1.

The chosen horizontal emergent beams K^3, K^6 from the gauge G are deflected downwards to the projection unit J by means of one or a pair of plane mirrors, the arrangement in each case being such that an erect image of the gauge is obtained on the diffusing screen J^4. Since the image is inverted by the lens J^1 and is also twice reflected in the projection unit J, a single plane mirror L (Figure 6) inclined at an angle of 45° to the vertical will serve to give an erect image of the gauge on the screen J^4 in cases where the mirror L is disposed in front of the gauge and the screen is viewed from the front. A pair of plane mirrors L^1, L^2 (Figure 7) inclined to one another at an angle of 45° will however be required in cases where the mirrors L^1, L^2 are disposed behind the gauge and the screen J^4 is viewed from the front. The plane mirror L or mirrors L^1, L^2 in each case consist of narrow vertical strips of a width sufficient to reflect the whole of the chosen beams K^3, K^6. It is not essential that the mirror or mirrors should lie out of the paths of the other emergent beams K^4, K^5, provided that these beams do not impinge on the projecting lens J^1.

The projection unit consists of a cylindrical metal casing J mounted on the firing floor and closed at its upper end by a plate glass window J^5. The convex projecting lens J^1 is mounted just below the window J^5 and is so arranged as to focus a real image of the gauge G at a point just below the lower end of the casing J, the convex mirror J^2 in turn focussing an enlarged image of such image on the ground glass diffusing screen J^4 after reflection in the narrow inclined plane mirror strip J^3, the diffusing screen being mounted in a lateral opening in the casing J near the upper end. In order to obtain an image on the screen J^4 of the same size as the gauge itself, the convex mirror J^2 may be located at the principal focus of the projecting lens J^1, the distance from the convex mirror to the screen J^4 after reflection at the mirror J^3 being equal to the focal length of the lens J^1.

British Patent Specification No. 387,752 above mentioned gives a full description of a variety of adjustments provided for the elements of the projection unit and for the other parts of the apparatus, and also of a number of modifications of the apparatus.

This arrangement enables a well-defined and brightly illuminated image of the gauge to be reproduced at eye level on the firing floor in such a manner that it can be readily seen over a wide angle of vision. The lower part of the indication will be brightly illuminated in green and the upper part brightly illuminated in red, since the rays K^4, K^5 do not impinge on the projecting lens J^1 and are consequently not reproduced on the diffusing screen J^4. The water level will thus be indicated by the dividing line between the two differently coloured parts of the image. This arrangement effectively prevents misinterpretation of the indication, which might occur with single-colour illumination when the gauge is completely empty or completely full.

Whilst it is generally preferable to employ two colours such as red and green so arranged that approximately equal intensities are obtained in the two colours, it will sometimes suffice to employ white light as one of the colours with the other colour derived from the same source through a colour screen. This can be effected by displacing the lamp H^1 slightly to one side of the centre of curvature of the reflector H^3 and interposing a colour screen between the lamp and the reflector. There will thus be in effect two point sources of light, one white and one coloured, so that two beams of light in slightly convergent vertical planes are directed on to the gauge.

Although described with reference to a boiler installation provided with a water level gauge at a height above the firing floor, the arrangements can be applied with suitable modifications to other purposes. Thus for instance the arrangements may also be employed with advantage in some cases, for example, with pulverised fuel boilers, where the firing floor is commonly at more or less the same height as the gauge, but where the gauge is located at the back of the boiler. The arrangements

are generally applicable to liquid level indicating purposes, where it is desired to obtain an indication at a distance from the point at which the gauge is installed.

Again the forms of gauge described may be employed with other arrangements for projecting the indication to a distant point, or they may be directly viewed without a projecting arrangement. In the latter case the apparatus is preferably arranged in the manner shown in Figure 10.

In this arrangement a vertical strip light N (or series of electric lamps disposed one above the other) is located behind a diffusing screen N^1, in front of which two colour screens O O^1 (e.g. red and green) are placed side by side the arrangement being such that substantially even illumination is obtained over the whole area of the colour screens. A cylindrical lens P is located close to the gauge Q (preferably constructed in the manner shown in Figures 1 and 2 with a wedge angle of 20°) in such a position that the colour screens O O^1 are in the focal plane of the lens. With this arrangement, what may be termed "flash" illumination of the lens P is obtained, that is to say, if the gauge were removed altogether, the whole of the lens P would appear illuminated in red when viewed from any direction within a certain angle (since all rays leaving the lens in any one such direction will have passed through some point on a vertical line in the red colour screen O) and would similarly appear illuminated in green when viewed from any direction within another contiguous angle. The gauge Q will act in the manner above described to separate out each incident vertical strip of light into two divergent vertical strips respectively above and below the water level. Thus to an observer walking past the gauge, say from the top to the bottom of the drawing, the gauge will first of all appear wholly dark, and then green above the water level and dark below, after which the gauge will appear in turn wholly green, then red above and green below, then wholly red, then dark above and red below, and finally wholly dark. With a suitable width and positioning of the colour screens in relation to the wedge angle of the gauge, the wholly red and wholly green indications can be made to disappear altogether, and a clear indication of the water level over a reasonably wide angle of vision can be satisfactorily obtained. The two colour screens should be chosen to give approximately equal intensities in the beams, and when so chosen, the water level is clearly indicated even at great distances from the gauge (at least within the central portion of the angle of vision where both colours are visible). It is often convenient to employ a simple form of periscope consisting of two plane mirrors each inclined at 45° to the vertical, so that the chosen emergent beams from the gauge are twice reflected at these mirrors, and it will be appreciated that with this arrangement the width of the lower mirror can be so chosen as to limit the field of vision to the central portion where the colours give the correct indication.

Figure 11 illustrates a modification of the arrangement of Figure 10, in which the strip light and diffusing screen N, N^1 and the colour screens O, O^1 are replaced by a pair of differently coloured vertical glow discharge tubes R, R^1, for example a neon tube and a mercury vapour tube, the arrangement in other respects being similar to that of Figure 10.

Figure 12 illustrates a further modification of Figure 10, in which an electric lamp S having a diffusing envelope, such for example as the wellknown opal or pearl lamps, is employed as the source of light, so that substantially even illumination over a small area is obtained. Red and green colour screens S^1, S^2 are arranged next to the lamp, so as to lie one on either side of the focus of a paraboloidal mirror strip T similar to the condensing mirror strip H^2 of Figures 6—9, and the rays reflected from the mirror T are incident directly on the gauge Q. This arrangement gives "flash" illumination of the mirror T and its operation will be clear without further description.

It will be appreciated that the arrangements above described have been given by way of example only and may be modified in a variety of ways within the scope of the invention.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In a liquid level indicating arrangement, the combination with a transparent liquid level gauge so arranged that two parallel rays of light incident on the gauge respectively above and below the liquid level will be deflected by the gauge through different angles, of means for directing two differently coloured beams of light on to the gauge at such an angle to one another that from a chosen observing point the gauge will appear as of one colour above the liquid level and of the other colour below the liquid level.

2. A liquid level indicating arrangement as claimed in Claim 1, in which a real image of the gauge is projected on

to a diffusing screen by means of an optical projecting system on which only the chosen emergent beam or beams are incident.

3. A liquid level indicating arrangement as claimed in Claim 2, in which the gauge is illuminated by a source of light in association with an optical condensing system so arranged as to concentrate the light from the source on the element or elements of the optical projecting system.

4. A liquid level indicating arrangement as claimed in Claim 1 or Claim 2 or Claim 3, in which the differently coloured beams are produced from a single source of light by interposing two colour screens between the source and the gauge, with or without means such as a prism for directing the beam of one colour at the desired angle on to the gauge.

5. A liquid level indicating arrangement as claimed in Claim 1, in which two colour screens evenly illuminated from a suitable source are disposed side by side in the focal plane of a lens or mirror, from which the differently coloured emergent beams are directed on to the gauge.

6. A liquid level indicating arrangement as claimed in Claim 1, in which two differently coloured glow discharge tubes are disposed side by side in the focal plane of a lens or mirror from which the differently coloured beams are directed on to the gauge.

7. A liquid level indicating arrangement as claimed in any one of the preceding claims, in which the gauge is of the kind having all its operative surfaces plane surfaces, the central space in the gauge containing the liquid column being in the form of a wedge or having a shape optically equivalent thereto.

8. The liquid level indicating arrangement substantially as described with reference to Figures 6—9 or Figure 10 or Figure 11 or Figure 12 of the accompanying drawings.

Dated this 2nd day of March, 1933.

KILBURN & STRODE,
Agents for the Applicants.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson. Ltd.—1933.

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

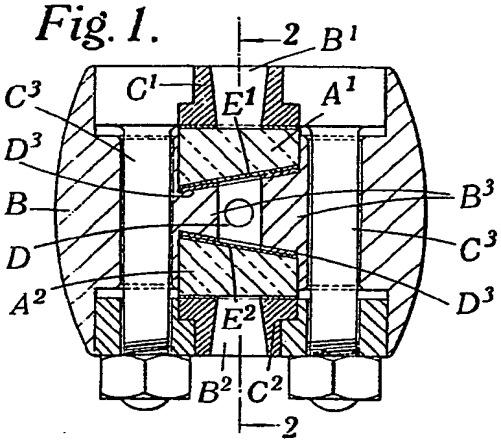


Fig. 3.

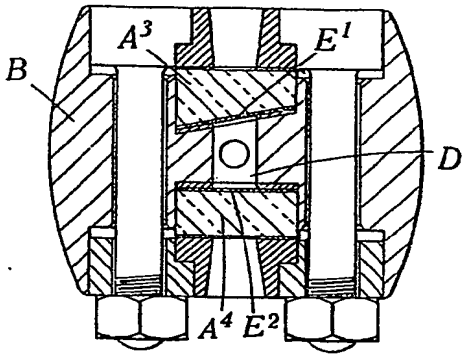
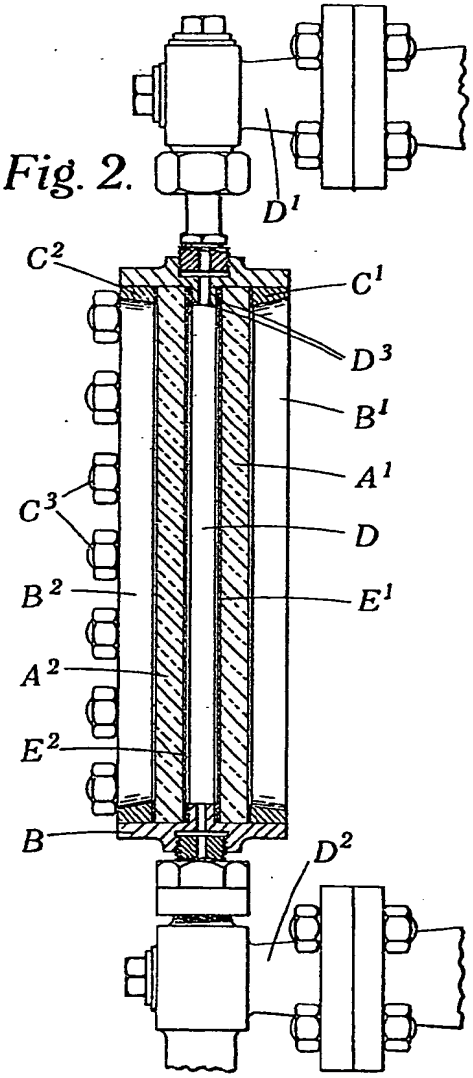


Fig. 2.



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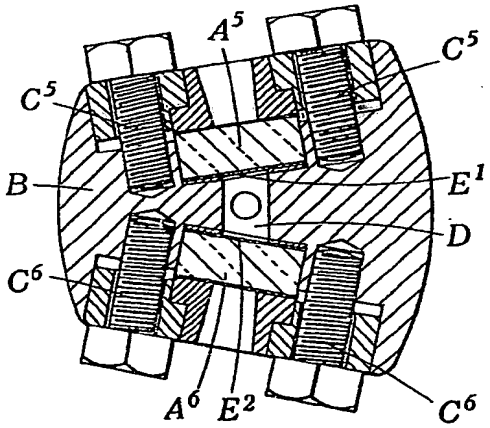

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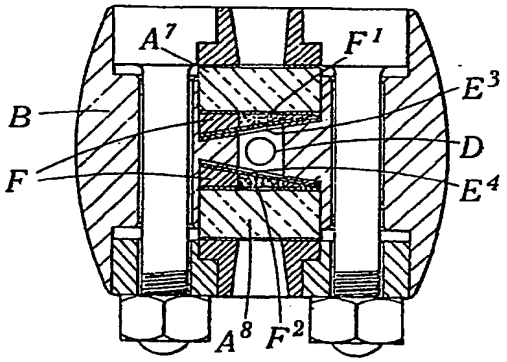

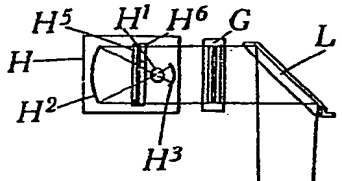

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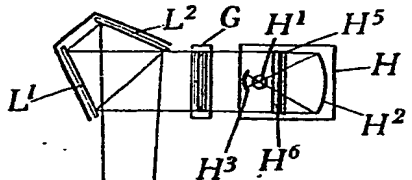

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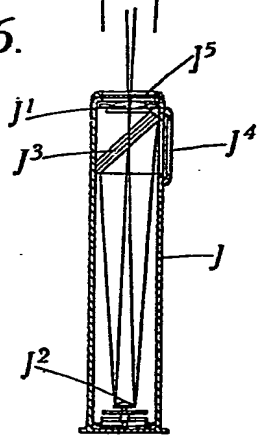

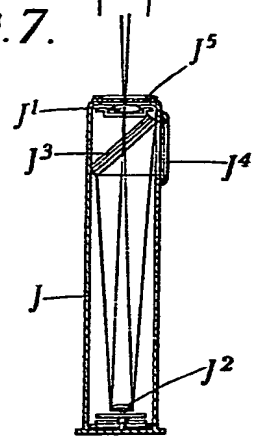

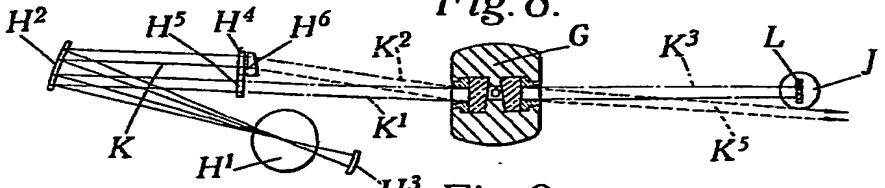

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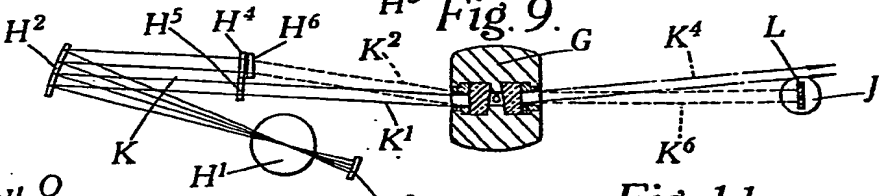

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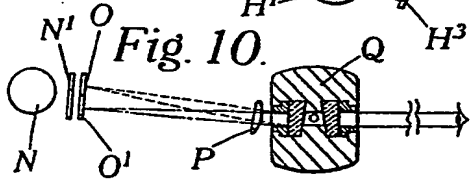

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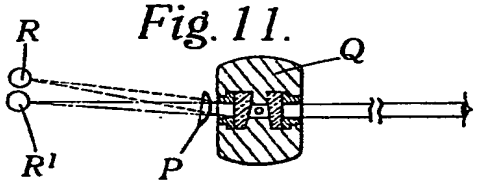

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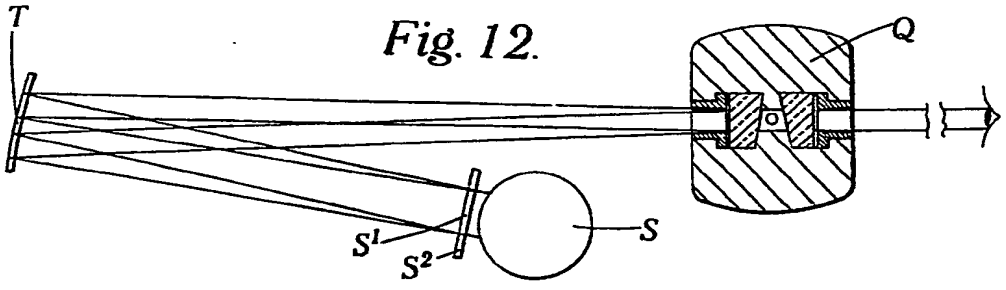

Fig. 12.

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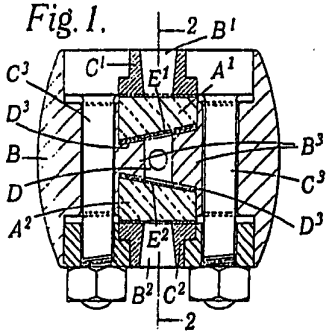

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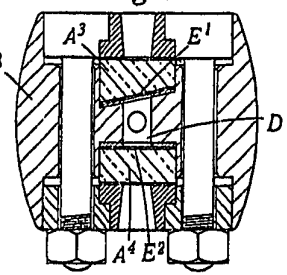

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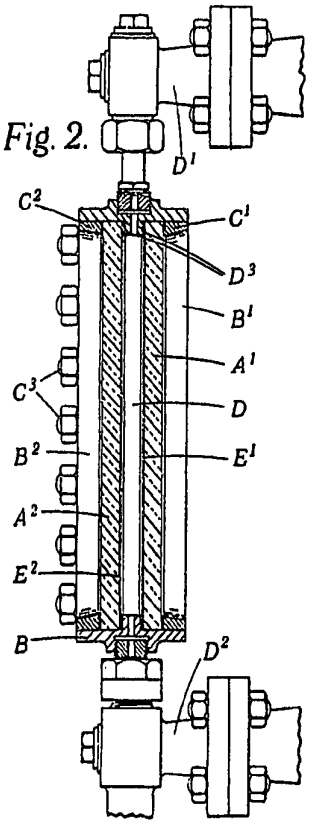

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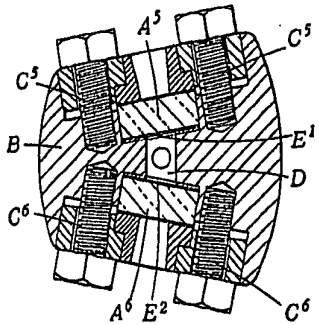

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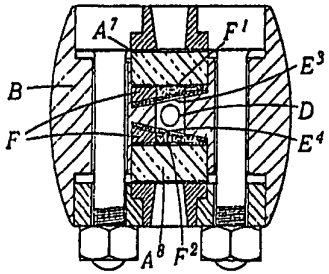

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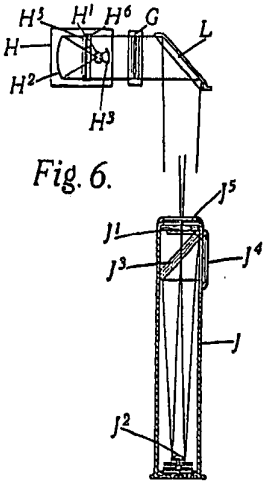

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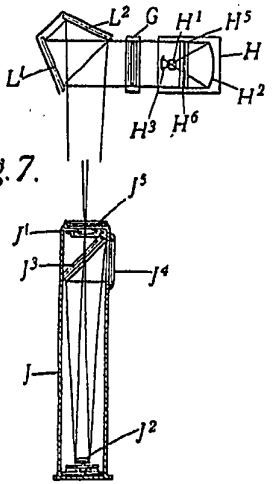

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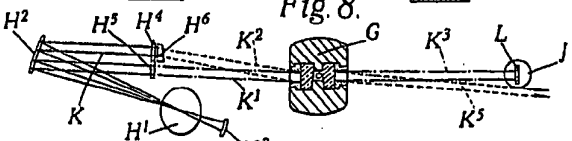

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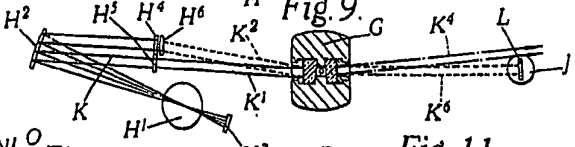

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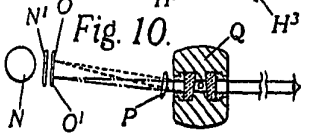

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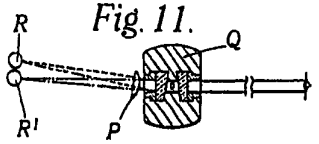

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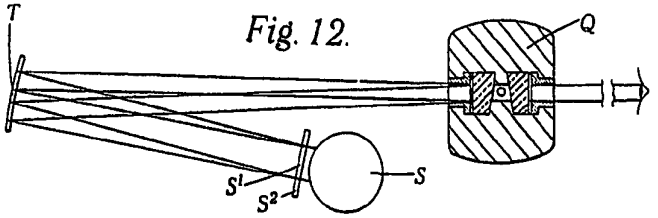

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